PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in or relating to Processes and Apparatus for the Preparation of Parboiled Rice.

I, DANIEL SALOMON FERNANDES, a Dutch Subject, of Soekilaka of Paramaribo (Surinam), do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to a process and apparatus for producing an improved parboiled rice, consisting of white, i.e., polished or milled, kernels, in which the thiamin content (vitamin B), originally present in the crude rice (padi) is retained for the full 100%; this is in contrast to all forms of parboiled rice so far produced, in the production of which only part of the vitamins of the B-complex from the hull (Silberhautchen) and the germ have been retained in the kernel, in spite of the fact that the starch in the kernel is completely gelatinized.

The invention aims more specifically at rendering possible the production of this improved parboiled rice by a continuous process.

As is known, the production of parboiled rice comprises three phases, the soaking, the steaming, and the drying of the natural rice.

A process for the treatment of rice or other cereals has been proposed, in which the rice, after preliminary cleaning, is transferred to a vessel in which firstly steeping and secondly steaming of the rice is carried out, the rice thus treated being subsequently transferred to a drying machine, the steeping being effected by water in a state of circulation and steaming being carried out at atmospheric pressure.

In the processing of rice, it is further known to dry heat the rice, after it has been soaked in a soaking tank to a water content upwards of 15%, in a rotating, closed chamber having a helical conveyor blade fixed therein, and comprising external and internal heating means to maintain in such chamber a temperature between 200° and 475°C., the rice being kept in this chamber until its temperature is in the region of 90° to 98°C. after which it is discharged.

With these known processes it has, however, not been possible to produce a parboiled rice, in which the thiamin content is retained for the full 100%, while no regular and complete supervision is maintained of the temperatures to which the product is heated during the various stages of treatment. It has, however, been found that the correct value of these temperatures and the possibility of keeping them perfectly uniform and at a constant level is an essential factor for the full conservation of the vitamin content in the rice. Moreover, in the known processes use is made of high steam pressures and/or a vacuum.

The present invention consists in part of a process for converting crude rice into parboiled rice, while conserving in the kernels, for the full 100%, the vitamin contents originally present in the crude rice, comprising the steps of first soaking the crude rice by imparting thereto, while in a thinly spread condition, a slowly progressing and rolling motion and supplying water to said kernels, at a temperature preferably between 75° and 95°C., so as to cause such water to permeate the kernels gradually, whilst the quantity of water supplied is at most only in slight excess of the quantity taken up by the kernels, whereby the minimum of vitamins are washed out of the kernels; whereafter the soaked rice is slowly conveyed in a thinly spread condition and with a rolling motion through an open vessel supplied with steam at a uniform temperature not exceeding 100°C., whereby the vitamins diffused in the kernels are fixed; and finally drying the parboiled rice at sub-

stantially atmospheric pressure and moderate constant temperature. Preferably the drying of the parboiled rice is effected by subjecting the rice, while imparting thereto, in thinly spread condition a slowly progressing and rolling motion, to a continuous air current of constant moderate temperature.

For the treatment of grain or other granular material, for instance for preparing same for decorticating or peeling, comprising one or more containers, adapted to be heated and having conveyor worms extending through it or them and several other conveyor containers, which are likewise adapted to be heated and are provided with subdivided conveyor worms, with which latter friction members co-operate. Other known apparatus consists of a vessel through which the grain is passed, devices for supplying heat and moisture to the grain, means for regulating such heat and moisture and a vessel for receiving the softened grain, which may then be mixed with other grain of equal softness naturally.

The apparatus according to the present invention comprises for soaking the crude rice, a cylindrical drum, open to the atmosphere and rotatable about its axis, means for introducing into said drum the crude rice to be treated, and a helical conveyor blade, disposed in said drum and extending the length thereof, said blade being secured by its outer margin to the inner wall of said drum, characterised in that the drum is provided at both ends with an end piece in the form of a hollow truncated cone; in that the helical conveyor blade extends through at least the cone at the discharge end of the drum, and in that a stationary foraminated central tube extends within said drum along the longitudinal axis thereof, said tube at one end being connected to means for admitting thereto a fluid medium at a suitable temperature for treating the crude rice.

Preferably also the soaked rice is treated with steam in a rotating drum having a helical conveyor blade secured therein, the steam being supplied through an axial foraminated tube and its temperature being controlled by the controlled admission of water therewith, longitudinal blades being fixed to the wall of said drums between the convolutions of the conveyor blade. Also the parboiled rice after hot steam treatment may be dried by passage through a rotating drum having a perforated wall and fitted with a helical conveyor blade and longitudinal intermediate blades as in the steam drum aforesaid, hot air being supplied to the interior of said drum by a fan through a perforated axial tube.

Of the three phases for the production of parboiled rice mentioned above, the steaming of the raw rice which has first been soaked, is most important for attaining the desired object. Indeed, it has been found that if the starch in the kernels is to be completely gelatinized, this treatment must be effected very uniformly at a clearly defined, accurately controlled and constant temperature, and to this end in the process according to the invention, the steaming is effecteed by a continuous process in thin layers and in such a manner that all the kernels attain the same temperature, not exceeding 100°C.

Furthermore the soaking of the crude rice as harvested and the drying of the steamed crude rice are also carried out by a continuous process, namely by moving the raw or steamed rice as the case may be in a relatively thin layer, without any pressure and at a controlled rate, continuously in water or in a permanent air-current as the case may be, of the desired controllable temperature.

As will be appreciated from the foregoing the three drums for soaking, steam heating and drying are similar in principle in that they provide for a slow rolling motion of the rice through the treating liquid or fluid in a continuous manner, although, as will hereafter appear, they differ somewhat in details of construction.

The entire process of parboiling may be carried out continuously in a manner guaranteeing the highest quality of the product, and a continuously operating plant comprising soaking, steam heating and drying apparatus arranged to operate in series on the rice also forms part of the invention.

Furthermore additional apparatus may be arranged to operate in series on the rice before and after the aforesaid apparatus. Thus for example apparatus for the cleaning of the raw rice may be provided in front of the soaking apparatus and a hulling, polishing and grading machine may be provided after the drying apparatus, so that the whole process of the conversion of crude rice into parboiled rice may be carried out in a single continuous process.

The invention will be explained more in detail in the following description with reference to the accompanying drawings of apparatus for carrying out the successive phases of treatment.

Fig. 1 is a more or less diagrammatic longitudinal section through an apparatus for the soaking of the crude rice;

Fig. 2 is a similar illustration of an apparatus for the steaming of the soaked crude rice, and

Fig. 3 illustrates an apparatus for the

drying of the kernels after the soaking and steaming;

Fig. 4 illustrates a modification of the apparatus according to Fig. 1, and

Fig. 5 illustrates another modification.

The apparatus according to Figs. 1, 2, and 3, are substantially identical and consist each of a horizontal, rotatable drum 1, to the wall of which a helical conveying member 2 has been peripherally fixed by welding or other suitable method. The drum which is perforated along the whole of its length only in the case of the apparatus according to Fig. 3, carries a pulley 3 for rotating the drum about its axis. The drum is rotatably supported by means of rollers 4 distributed along the length of the drum.

At the charging and discharging ends the drum 1 has conical nozzles 5 and 6 respectively, the former of which is rotatably supported by a hollow sheet metal cone 7, which is mounted on supports 8 and carries a hopper or charging funnel 9 for the crude rice to be treated. The conveyor 2 extends through the discharge nozzle cone 6. A neck 10 of the cone 7 lies coaxially round a tube 11, which extends axially through the drum and is mounted adjacent to each end of the drum on supports 12. Inside the drum 1 the tube is perforated at 13, whilst, at least in the case of the apparatus according to Figs. 1 and 2, to the open end 14 of the tube 11 are connected a supply conduit 15 for water with control cock 16, and a supply conduit 17 for steam with control cock 18. In the case of the apparatus according to Fig. 2, the axial tube 11 is of slightly larger diameter than in the apparatus according to Fig. 1, whilst in the apparatus according to Fig. 3 the tube 11 is of greater diameter still (10 cm) and instead of being connected to steam and water supply conduits, is connected to a fan 19, or other device for supplying heated air under pressure and at a controllable temperature. Near the exit end of drum 1 its wall is provided with an opening 21, which can be closed by a plug 20.

In the apparatus according to Figs. 2 and 3, i.e., those for steaming and drying the crude rice, four uniformly distributed radial baffles 28 are provided on the inner wall of the drum 1, which baffles are slotted to accommodate the conveyor screws 2 and extend the whole length of the drum, so that the kernels of rice to be steamed or dried and moving along the drum are raised in the rotating drum before dropping from one conveyor section into the next. In the apparatus according to Fig. 1, for the soaking of the crude rice, no baffles 28 are provided, because in this case the crude rice has to be kept in the hot water as long as possible.

Fig. 4 illustrates a modified form of the discharge end of the drum 1 for the apparatus according to Fig. 1, i.e., for the soaking of the crude rice.

According to this modification the discharge end of the drum 1 is provided with an extension piece 22 having a perforated wall and a conical nozzle end, into which extension piece the conical nozzle 6 extends. In the extension piece 22 is fixed a helical conveying member 23, whilst underneath the extension piece a liquid receptacle 24 is provided. The perforated tube 11 extends beyond the discharge end of the extension piece 22, and its projecting end, as in Fig. 1, is mounted on a support 12. In this modification the soaked crude rice leaves the drum at the end of the extension piece free from water, which drains away through the perforations in extension piece 22 into receptacle 24.

According to another modification of the apparatus according to Figs. 1 and 4, illustrated in Fig. 5, a perforated tube 29, through which steam is blown into the water to keep the latter at the desired temperature, is disposed in the receptacle 24, which is then made sufficiently large and remains filled with water. By means of a double-acting suction pump 30 connected to the receptacle 24 the hot water is conveyed from the receptacle 24 via conduit 31, to the inlet end 14 of the tube 11, from which, after having performed its work, it returns to the receptacle 24 via the perforated extension piece 22. No steam is then blown into the tube 11 at 14. Thus the heat present in the waste water is recovered, whilst owing to the presence of the double-acting pump 30 a greater pressure is available for cleaning the apparatus after use when desired.

The successive phases of the production process will now be described with reference to the drawings.

SOAKING.

The kernels of crude rice have to be soaked, i.e., saturated with water, in the course of which the vitamins of the B-complex chiefly present in the outer cell layers and the germs diffuse towards the centre and are thus uniformly distributed throughout the kernel. This soaking takes place in the apparatus according to Fig. 1.

The crude rice to be treated is introduced into the hopper or funnel 9 and drops via the cone 7 into the rotating drum 1, wherein it is moved slowly and in a relatively thin layer uniformly to the discharge end by the helical conveying member 2. In the drum water and/or steam is introduced into the stationary perforated tube 11 by means of the conduits 15 and 17 and under the control of the cocks

16 and 18, so that in the lower part of the drum a layer of hot water 25 collects, the level of which is kept constant by the conical nozzle ends 5 and 6 of the drum, and through which the crude rice is continuously moved by the helical conveying member 2. The water continuously fed in slight excess of the quantity taken up by the kernels, overflows at 26, so that the soaking bath is in slow, flowing motion. The temperature of the water, which can be accurately determined by control of the steam supply, is also kept constant in this manner. The water flowing out of drum 1 may be returned by means of a pump to the rotating drum 1 via the tube 15, as long as this water remains clean enough.

The duration of the soaking process depends on the kind of crude rice to be treated and the temperature at which the water is kept. It is determined empirically. Suitable temperatures are those between 75 and 95°C. The soaking process described can be accurately controlled and can be checked during operation. The degree of saturation of the kernels can be ascertained with a moisture-tester. The soaked crude rice leaves the apparatus continuously at 26.

In order to clean the drum after use, the steam cock 18 is closed and the water cock 16 opened full, as a result of which the tube 11 acts as a water sprayer. The plug 20 is then removed, so that all residues are discharged through the opening 21, which may have a diameter of, for example, 10 cm. The water used for soaking must not be alkaline, as this has an adverse effect on the vitamin content of the final product.

THE STEAMING OF THE SOAKED CRUDE RICE.

The object of the steaming of the soaked crude rice, which is the operation chiefly determining the nature of the product, consists in a complete gelatinization of the starch in the kernels of rice, so that the vitamins are retained. Up to the present it is this treatment which has involved the greatest difficulties, because it was impossible to carry out the treatment continuously and perfectly uniformly while constantly checking the temperature accurately. It has been found that these requirements can be met by continuously moving the soaked crude rice in a relatively thin layer in a moist steam medium without pressure and having a given constant temperature. Each kernel of rice is then subjected to the steam treatment in an identical manner, so that a substantially perfectly and uniformly steamed product is obtained, in contrast with that obtained with the discontinuous method hitherto used, according to which the soaked crude rice is steamed in reservoirs by means of steam which is fed into the rice mass via perforated pipes, with the result that the kernels lying against or nearest the steam pipes are steamed more intensively than the rest. By reason of the perfect supervision of the temperature which is possible with the process according to this invention, care can be taken that any desired critical temperature is not exceeded, which is of essential importance in view of the insight gained that the conservation of the vitamin B_1 content in the final product depends on the temperature to which the soaked rice kernels are raised by the steaming. This important factor has not, or has not sufficiently, been taken into account up to the present. If the crude rice is steamed under pressure, the temperature of the rice kernels rises to upwards of 100°C. At this temperature part of the vitamins are denatured, so that the vitamin content of the steamed rice becomes lower than that of the crude rice started from.

The steam treatment according to the invention is carried out in a similar apparatus (Fig. 2) to that used for the soaking (Fig. 1).

The soaked crude rice is introduced into the rotating drum 1 via the hopper or funnel 9 and the cone 7, and therein it is raised by the longitudinal blades baffle 28 between the convolutions of the conveyor 8 and slowly advanced by the helical conveying member 2, the opening 21 having been opened by removal of the plug 20 in order to permit continuous discharge of the steamed product. The steam is fed through the conduit 17 and so controlled by means of the cock 18 that no needless loss of steam takes place. If the full vitamin value is to be conserved, the temperature of the soaked crude rice during the steaming must not be raised beyond 100°C., to which end, simultaneously with the steam, such a quantity of water is fed through the conduit 15 that the temperature of the steam leaving the perforations of the tube 11 does not exceed 100°C. By this means the process is also rendered independent of the steam pressure in the boiler.

The condensation water flowing off at 21 will then have a temperature between 90 and 95°C., so that the steamed rice can at most have a temperature of 95°C. on leaving the apparatus.

When treating kinds of crude rice which will not stand this temperature, because they are then liable to burst from the hull and then become practically boiled, the drum 1 may be rotated more rapidly and the temperature thus reduced, for example, to 80°C., and kept at this value. The same result may be attained by adding more water to the steam. Once the critical temperature for a given kind of crude rice is known, the process can be perfectly and

accurately controlled, and kept constant by means of the cocks 16 and 18 and the rate of rotation of drum 1.

DRYING.

The drying of the parboiled rice is an operation which has to take place very carefully, because with too rapid heating or too high temperatures, sometimes even at 45°C., small cracks are formed in the rice kernels, which, when the rough rice is hulled in to rice for consumption, cause a high percentage of broken kernels.

It has been found that the occurrence of small cracks is prevented by means of the process according to the invention, if the steamed kernels of rice are slowly and continuously moved in a thin layer in an air current of constant, not too high a temperature. This process is carried out in the apparatus according to Fig. 3. The perforated tube 11, which now has a diameter of about 10 cm and is closed at the free end by means of a cap 27, is connected at the other end to a fan 19 adapted for blowing in heated air, which enters the rotating drum through the perforations of the tube 11, passes between the convolutions of the helical conveying member, and finally leaves the drum through the wall, which in this case is perforated. The steamed rice is fed to the helical conveying member 2 again via the hopper 9 and the cone 7, and slowly moved in a thin layer in the permanent air-current of constant temperature created by the fan, the kernels being raised by the baffle blades 28 between the convolutions of conveyor 2, and continually falling down and turning round, and being swept separately and on all sides by the drying air. The capacity of the fan is so chosen that all the water vapour liberated is completely discharged along a short path, *viz*, the distance between the the layer of rice and the upper side of the rotating drum 1, in contrast with drying according to the counter-current principle.

The critical temperature for the drying air is ascertained empirically. The temperatures depend on the variety of rice to be treated, i.e., they differ according as rice with long or short kernels is being treated.

The dried parboiled rice leaves the apparatus continuously through the opening 21, which is opened before drying is started.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A process for converting crude rice into parboiled rice, while conserving in the kernels, for the full 100%, the vitamin contents originally present in the crude rice, comprising the steps of first soaking the crude rice by imparting thereto, while in a thinly spread condition, a slowly progressing and rolling motion and supplying water to said kernels, at a temperature preferably between 75° and 95°C., so as to cause such water to permeate the kernels gradually, whilst the quantity of water supplied is at most only in slight excess of the quantity taken up by the kernels, whereby the minimum of vitamins are washed out of the kernels; whereafter the soaked rice is slowly conveyed in a thinly spread condition and with a rolling motion through an open vessel supplied with steam at a uniform temperature not exceeding 100°C., whereby the vitamins diffused in the kernels are fixed; and finally drying the parboiled rice at substantially atmospheric pressure and moderate constant temperature.

2. A process according to Claim 1, wherein the drying of the parboiled rice is effected by subjecting the rice, while imparting thereto, in thinly spread condition, a slowly progressing and rolling motion, to a continuous air current of constant moderate temperature.

3. Apparatus for carrying into effect the process according to Claim 1 or 2, comprising for soaking the crude rice a cylindrical drum, open to the atmosphere and rotatable about its axis, means for introducing into said drum the crude rice to be treated, and a helical conveyor blade, disposed in said drum and extending the length thereof, said blade being secured by its outer margin to the inner wall of said drum, characterised in that the drum is provided at both ends with an end piece in the form of a hollow truncated cone; in that the helical conveyor blade extends through at least the cone at the discharge end of the drum, and in that a stationary foraminated central tube extends within said drum along the longitudinal axis thereof, said tube at one end being connected to means for admitting thereto a fluid medium at a suitable temperature for treating the crude rice.

4. Apparatus according to Claim 3, wherein the conical end piece at the feeding end of the drum is rotatably supported by a stationary hollow cone, having a feed hopper associated therewith.

5. A modification of the apparatus for soaking the crude rice according to Claim 3 or 4, wherein beyond its discharge end, the drum is provided with an axial extension piece having a foraminated wall, and comprising a helical conveyor blade axially extending therethrough and secured along its outer periphery to the inner wall of said extension piece, a fluid receptacle being disposed beneath said extension piece, and

the soaked rice freed from fluid being discharged from the end of said extension piece.

6. A modification of the apparatus according to Claim 5, wherein the fluid receptacle is connected to the intake of a double acting pump, the pressure side of which is connected to the inlet end of the central foraminated tube for supplying the fluid medium to the drum, and wherein means are provided for supplying heating steam to the fluid medium accumulating in the receptacle.

7. Apparatus according to any of the preceding Claims 3—6 inclusive for carrying out the process according to Claim 1 or 2, wherein the soaked rice is treated with steam in a rotating drum having a helical conveyor blade secured therein, the steam being supplied through an axial foraminated tube and its temperature being controlled by the controlled admission of water therewith, longitudinal baffle blades being fixed to the wall of said drum between the convolutions of the conveyor blade.

8. Apparatus according to any of the preceding Claims 3—7 inclusive for carrying out the process according to Claim 1 or 2, wherein the parboiled rice after hot steam treatment is dried by passage through a rotating drum having a perforated wall and fitted with a helical conveyor blade and longitudinal baffle blades between the convolutions of the conveyor, as in the steam drum according to Claim 7, hot air being supplied to the interior of said drum by a fan through a perforated axial tube.

9. Plant for carrying out the process according to Claim 1 or 2, comprising rice soaking, steaming, and drying devices according to Claims 3 or 4 (or modified according to Claim 5 or 6), Claim 7, and Claim 8 respectively, arranged to operate in series on the rice in a continuous manner, with or without additional apparatus for pre-treating the crude rice and after-treating the parboiled rice, also disposed in series in front of, and following the said soaking steaming and drying devices.

10. Process for the preparation of parboiled rice, substantially as herein described with, or without reference to the accompanying drawings.

11. Apparatus or plant for carrying into effect the process according to Claim 10, substantially as herein described with reference to, and as illustrated by the accompanying drawings.

Dated this 24th day of November, 1948.

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SHEET 1

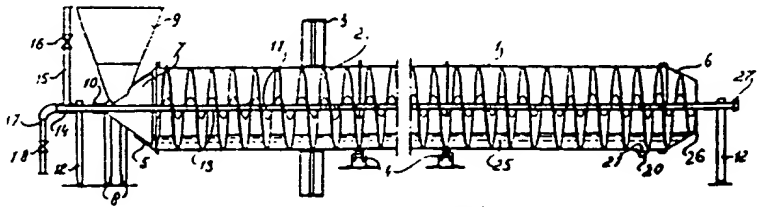

Fig.1.

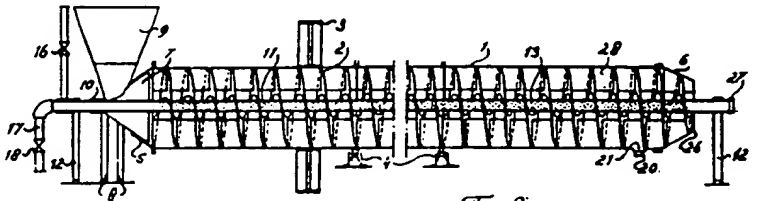

Fig.2.

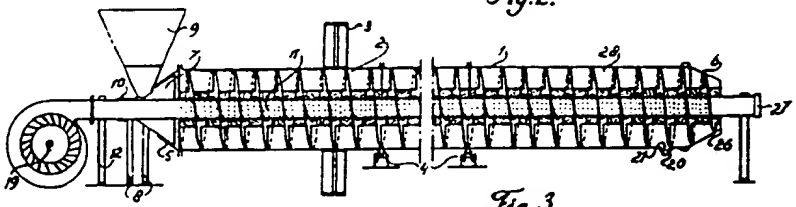

Fig.3.

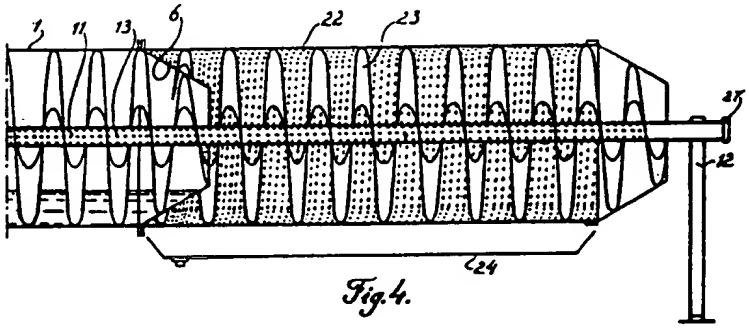

Fig.4.

SHEET 2

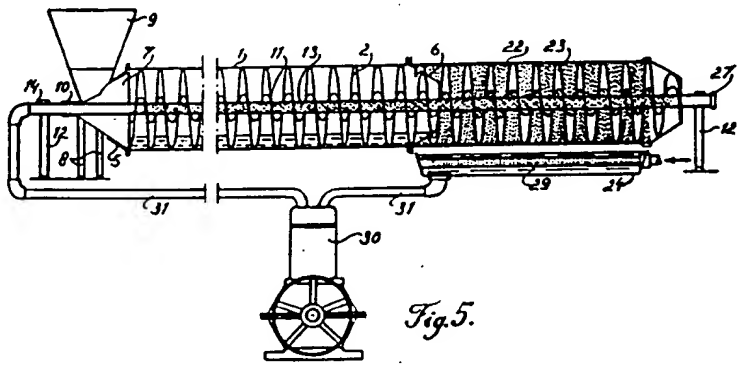

Fig.5.